

Association between respiratory tract infections and incidence of falls in nursing home residents

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KEY WORDS

aging, falls, fractures, functional abilities, infections

ABSTRACT

INTRODUCTION Falls are complex incidents caused by a combination of intrinsic impairments and disabilities with or without accompanying environmental hazards.

OBJECTIVES The aim of the study was to assess the relationship between respiratory tract infections (RTIs) and the incidence of falls, and to further link the history of falls to functional status in nursing homes residents.

PATIENTS AND METHODS The study involved 255 residents at 3 nursing homes aged 65 years and older. Falls and RTIs were registered during 1 year, and, afterwards, a comprehensive geriatric assessment was performed in each subject.

RESULTS Falls occurred in 104 subjects, and 17 falls resulted in a fracture. The waist-to-hip ratio (WHR) was lower among subjects with fractures compared with those without fractures. Subjects with a fracture in history had a significantly worse functional status in terms both of basic and instrumental daily activities. Nursing home residents with a history of falls more often suffered from infections than those without such history (1.53 ± 1.31 vs. 1.03 ± 1.17 , respectively, $P < 0.001$). Similarly, subjects with a history of fractures more often suffered from infections than those without such history (1.82 ± 1.07 vs. 1.19 ± 1.26 ; $P = 0.012$). After adjustment for other covariates in a multivariate model, RTIs remained an independent predictor of falls and fractures.

CONCLUSIONS The risk of falls and fractures in nursing home residents is associated with the occurrence of RTIs. A low WHR is a risk factor for falls with fractures. Older subjects with a history of fracture are characterized by a worse functional status. Preventing infections may probably reduce the number of falls and fractures in older nursing homes residents.

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INTRODUCTION A fall is defined as “unintentionally coming to the ground or some lower level and other than as a consequence of sustaining violent blow, loss of consciousness, sudden onset of paralysis as in stroke or an epileptic seizure”.^{1,2} Falls are the main cause of mortality, morbidity, disability, reduced functioning, and premature nursing home admissions in elderly patients.^{3,4} Older people in nursing homes fall more often than those who live in the community.^{3,5} One in every 3 older community-dwelling adults and at least half of the nursing home residents aged 65 years and older have a history of at least 1 fall each year. Half of them fall more than once a year.^{4,6} Around

5% of the falls are followed by a fracture and 20% of the falls require medical intervention.⁶

In addition to physical injuries and death, falls can produce other serious consequences; for example, falls are a common reason for the admission of previously fit older subjects to long-term care institutions.³ Another common result of falls is a condition associated with the fear of falling called post-fall anxiety syndrome.⁷ It leads to functional decline, poor quality of life, and social isolation. It increases the risk of falling, and, as a consequence, it leads to a significant reduction in physical activity and a further deterioration of overall health as a result of inactivity.⁸ Severe

injurious falls in the elderly significantly affect healthcare costs.⁹ Between 0.85% and 1.5% of total healthcare expenditure is spent on the medical repercussions of falls.¹⁰

Falls are complex incidents caused by a combination of intrinsic impairments and disabilities with or without accompanying environmental hazards.⁶ The functional status of the elderly may be affected by a history of infections. Respiratory tract infections (RTIs) are a common cause of death and may lead to the deterioration of overall health.¹¹ Similarly to falls, infectious diseases lead to increased rates of hospitalization, morbidity and mortality in the elderly, especially among people older than 85 years of age.¹² Owing to the physiological changes associated with aging, the presence of coexisting diseases, and the environment in which they reside, nursing home residents are more susceptible to infections.¹³

It has been widely accepted in geriatric literature that a fall may be the first indicator of numerous acute problems, such as infection.³ Nevertheless, there are a paucity of data in the available literature directly examining the association between infections and falls. Therefore, the aim of the present study was to assess the relationship between RTIs and the incidence of falls and to further link the history of falls to a functional status in nursing home residents. We hypothesized that infections may significantly increase the risk of falling among older institutionalized subjects.

PATIENTS AND METHODS **Patients** The study was conducted from May 2008 to March 2011 and involved residents aged 65 years and older of 3 nursing homes. The inclusion criteria were age, ability to participate in physical function (balance and gait) tests, verbal communication efficiency, and patient's consent. Of all nursing home residents, fewer than 40% were able to participate in the study (residents with severe dementia or who were bed-ridden were excluded).

A total of 255 nursing home residents who met the inclusion criteria (213 women and 42 men; age, 65 to 99 years; mean age, 79.1 ± 7.3 years) participated in the study. Participants had been diagnosed with the following concomitant diseases: arterial hypertension ($n = 198$), chronic heart failure ($n = 188$), ischemic heart disease ($n = 153$), history of myocardial infarction ($n = 36$), history of stroke ($n = 62$), diabetes ($n = 56$), osteoarthritis ($n = 145$), eye diseases ($n = 94$), osteoporosis ($n = 96$), urinary incontinence ($n = 146$), fecal incontinence ($n = 88$), hypercholesterolemia ($n = 77$), depression ($n = 63$), chronic obstructive pulmonary disease ($n = 63$), gastrointestinal diseases ($n = 55$), and cancer ($n = 26$). Moreover, 116 patients (45.5%) were vaccinated for influenza during the last year. Thirty-two subjects (12.6%) were current smokers. Clinical data were confirmed with medical records obtained from nursing homes and family physicians. The study was approved by the Bioethics

Committee of the Medical University of Łódź and written informed consent was obtained from all subjects.

Methods Each subject underwent a multidimensional assessment, which included demographic and social parameters, health status, physical function, and mental status. Falls and infections had been recorded over the period of 1 year before the clinical and functional examinations. The number of falls and the number of falls with fractures were recorded. An episode of infection was diagnosed when cold symptoms (runny stuffy nose, sore throat, coughing, sneezing, colored discharge), flu symptoms (fever, headache, general aches and pains, fatigue and weakness, chest discomfort, cough), or pneumonia were reported for more than 2 days and were separated by at least 1 day from the previous episode.¹⁴

The nutritional and functional status of respondents was evaluated by measurements and scales included in the comprehensive geriatric assessment. The nutritional state was assessed by the body mass index (BMI), waist-to-hip ratio (WHR), calf circumference, as well as the Mini Nutritional Assessment questionnaire (MNA).^{15,16} The MNA questionnaire contains 18 questions relating to the essential elements of the nutritional state, such as food intake, loss of body weight, the ability to move around independently, the occurrence of acute disease or stress, neurological problems, BMI, number of medications, and assessment of the arm and calf circumferences. The subject could score from 0 and 3 points for each question. The total number of points in the MNA questionnaire is 30.¹⁷

Physical functioning was assessed with the Activities of Daily Living (ADL) scale, Instrumental Activities of Daily Living (IADL) scale, and Timed Up and Go (TUG) test. The ADL scale consists of 6 questions, which are used to assess the ability to do basic activities such as bathing, use of the toilet, dressing, eating, and mobility.¹⁸ The IADL scale is used to assess the complex activities of daily living.¹⁹ It has 8 components: using the phone, shopping, cooking, cleaning, washing, using the means of transport, using medication, and using money.¹⁹ The TUG test evaluates gait and balance. The patient is asked to rise from a chair, walk 3 meters, turn around, walk back to the chair, and sit down in the starting position. A score above 14 seconds indicates an increased risk of falling. People without disabilities complete the test in about 10 seconds.²⁰ Participants were classified either to a group of nondisabled people (if the test time did not exceed 14 seconds) or a group of disabled people (if the test time was longer than 14 seconds or the subject was not able to complete the test).

Cognitive functions were evaluated using the mini-mental state examination (MMSE)²¹ and the 15-item geriatric depression (GDS) scale.²² The MMSE consists of 20 items and scores from 0 to 30 points, where the higher scores indicate better cognitive functioning. The questions are

TABLE 1 Comparison of the group with at least 1 fall with the group without falls during 1 year

	Fallers (n = 104)	Nonfallers (n = 151)	P
age, y	80.1 ± 7.16	78.4 ± 7.41	0.069
women, %	85.6	82.1	0.46
BMI, kg/m ²	25.4 ± 5.55	26.3 ± 7.51	0.34
WHR	0.84 ± 0.13	0.85 ± 0.12	0.29
calf circumference, cm	32.0 ± 4.54	32.8 ± 4.52	0.12
MNA	10.1 ± 2.28	10.6 ± 2.38	0.075
ADL	3.50 ± 2.00	3.79 ± 2.17	0.053
IADL	1.75 ± 1.90	2.15 ± 2.14	0.18
percentage of nondisabled people according to TUG, %	13.5	21.9	0.12
MMSE	21.6 ± 6.02	21.9 ± 5.36	0.85
GDS	7.28 ± 2.95	7.53 ± 3.46	0.63
number of infections / year	1.53 ± 1.31	1.03 ± 1.17	0.00025

Data are presented as mean ± standard deviation.

Abbreviations: ADL – Activities of Daily Living, BMI – body mass index, GDS – Geriatric Depression Scale, IADL – Instrumental Activities of Daily Living, MNA – Mini-Nutritional Assessment, MMSE – Mini Mental State Examination, TUG – Timed Up and Go test, WHR – waist-to-hip ratio

grouped into 7 categories, each representing a different cognitive domain or function. The GDS contains 15 questions characterizing a person's depressive status.

Statistical analysis Data were assessed for normality of distribution and equality of variances. The one-way analysis of variance, Mann–Whitney test, and χ^2 test (3×2 and 2×2 with Yates' correction) were used to compare the groups. A multiple logistic regression was used to verify whether RTIs were independent predictors of fall and fracture incidence in nursing home residents. Odds ratios (OR) and confidence intervals (CI) with 95% confidence limits were calculated. The values for number of infections per year were normalized using a log transformation for the purpose of multivariate statistical analyses. A statistical analysis was performed using the statistical program, Statistica 10th CSS. The results of the quantitative variables are presented as means ± standard deviation. The level of significance was set at a *P*-value of 0.05 for all analyses.

RESULTS A comparison of the group with at least 1 fall with the group without falls during 1 year is presented in [TABLE 1](#). A total of 104 subjects of the 255 surveyed had a history of at least 1 fall during 1 year. The falls occurred with a similar frequency in men (36%) and women (42%). There was a tendency which indicated a relationship between an increased risk of falling and the age of the respondents, as well as between the occurrence of a fall during the last year and a worse nutritional status as measured by the MNA questionnaire and a worse functional status according to the ADL scale. The values of BMI, WHR, IADL, calf circumference, MMSE, and GDS did not differ significantly between the 2 groups. A significant correlation was observed between the number of infections and the occurrence of falls: nursing home

residents with a history of a fall suffered from more infections than those without such history. Among 104 subjects with a history of falls, 81 seniors (77.9% of the group with a fall) suffered from at least 1 infection during 1 year. Infections were reported in 88 of 151 nonfallers, representing 58.3% of the group without any history of a fall ([TABLE 1](#)).

A comparison of the group with at least 1 fall and a fracture with the group with no fracture during 1 year is presented in [TABLE 2](#). Of the 104 nursing home residents who had fallen in the last year, 17 had experienced a fall-related fracture. These subjects were characterized by a lower WHR and had a tendency towards a lower BMI and a worse nutritional state according to the MNA scale as compared with the group without a fracture. A group of seniors with a history of a fall with a fracture had lower scores in the ADL and IADL tests. A tendency towards a worse functional status was also noted with the TUG test: among 17 people who had suffered a fracture, no one was classified as “mobile” according to the TUG test. A significant correlation was observed between the number of infections and the incidence of fractures. Of 17 subjects who suffered fall-related fractures, 15 had at least 1 infection (88.2% of this group), while among 238 people who did not suffer a fracture, 154 (64.7%) had an infection ([TABLE 2](#)).

In the logistic regression model, the effect of all independent variables on a dependent variable, namely, the incidence of falls and fractures, was analyzed simultaneously. Independent variables included age, sex, concomitant diseases, current smoking, infection incidence, influenza vaccination, anthropometric data (BMI, WHR), nutritional status (calf circumference, MNA), and physical (ADL, IADL, TUG) and mental (MMSE, GDS) functioning.

The number of infections per year was the only independent predictor of fall incidence (OR,

TABLE 2 Comparison of the group with at least 1 fall and a fracture with the group with no fracture for 1 year

	Fracture (n = 17)	No fracture (n = 238)	P
age, y	78.9 ± 5.89	79.1 ± 7.44	0.95
women, %	94.1	82.8	0.17
BMI, kg/m ²	23.4 ± 4.20	26.1 ± 6.88	0.067
WHR	0.81 ± 0.11	0.85 ± 0.12	0.04
calf circumference, cm	31.7 ± 4.10	32.5 ± 4.57	0.44
MNA	9.65 ± 2.03	10.5 ± 2.36	0.09
ADL	2.76 ± 2.27	3.74 ± 2.08	0.045
IADL	0.94 ± 1.30	2.06 ± 2.08	0.027
percentage of nondisabled people according to TUG, %	0.0	19.8	0.09
MMSE	20.7 ± 6.48	21.8 ± 5.57	0.54
GDS	7.35 ± 2.96	7.43 ± 3.28	0.86
number of infections / year	1.82 ± 1.07	1.19 ± 1.26	0.012

Data are presented as mean ± standard deviation.

Abbreviations: see [TABLE 1](#)

1.40; 95% CI, 1.12–1.74; $P = 0.0003$). Similarly, the number of infections per year was the only independent predictor of falls with related fractures (OR, 1.36; 95% CI, 1.00–1.87; $P = 0.018$).

DISCUSSION The risk of falling is associated with various factors, including internal (dependent on the patient), external (dependent on the environment), or behavioral factors (dependent on the type of activity undertaken).^{23,24} Clinical experience and the results of previous studies showed that multidirectional fall prevention strategies are the most effective among the elderly. They can reduce the number of falls by 20% to 45%.⁶ Therefore, identification of risk factors can help develop more effective intervention programs. The most important conclusion of the present study is that there is a significant relationship between the history of RTIs and the risk of falling in older nursing home residents. Our results showed that infections accompany the falls of almost 78% of the seniors with a history of falling. Furthermore, it has been shown that infections are strongly associated with the occurrence of fractures: the presence of at least 1 infection affects as many as 88% of the subjects with a history of fracture. After adjustment for other covariates in the multivariate model, RTI remains an independent predictor of incidence both of falls and falls with a fracture.

The population of elderly patients living in nursing homes is more susceptible to infections owing to physiological changes associated with age (reduced immunity and ciliary transport, cough reflex, weaker ventilation), coexisting chronic diseases, and the characteristics of the environment in which they live.^{13,25} Every acute disease increases the risk of falling through the deterioration of the general condition and mobility of the patient. In addition, a fall among elderly people, as a nonspecific symptom, may be the first manifestation of acute illness or exacerbation of a chronic disease.^{3,25,26} Surprisingly,

although infections have been widely considered as risk factors of falls, direct evidence on this relationship has been scarce. There has been only one available study that reported a relationship between urinary tract infections and fall incidence in the nursing home setting.²⁷

Early identification of older people with RTIs as being those with a high risk of falling will enable preventive action to be taken at the right time. Such strong associations obtained in the the current study emphasize the importance of infections as a factor contributing to an increased risk of falling and point to the need for programs of fall prevention, for instance, vaccination against influenza. Long-term studies have confirmed that there is a significant association between vaccinations and a reduced risk of hospitalization due to influenza, pneumonia (about 27%), and death (about 48%) of older community-dwelling adults.²⁸ Meanwhile, in Poland, despite the recommendation to older people over 70 years of age to take advantage of vaccination programs, especially those who are nursing home residents, only a little more than a quarter of the surveyed population have ever been vaccinated in their lifetime, and only half of them were vaccinated last year.²⁹

The majority of the available studies demonstrated that the risk of falling and of related injuries increases with age.⁸ In our study, a trend towards a significant relationship between age and the risk of falling was observed. As a rule, women fall more frequently, which is due to the fact that age-related limitation of physical activity is greater among women than among men, possibly because of greater (age-related) fear of falling.^{8,23} A fear of falling is reported by 70% of those who have fallen, and, in turn, it limits daily activities and further increases the risk of falling.⁷ The effect of chronic diseases and deterioration of physiological indicators, such as a greater and more rapid rate of decline in lean body mass, may differ between men and women.²³ Women

are more likely than men to experience nonfatal falls, but men are more likely to experience fatal falls.³⁰ Half of the nursing home residents fall at least once a year, and from 3% to 6% of the falls are followed by a fracture.^{6,31-33} In our study, 41% of the respondents experienced at least 1 fall during 1 year, but more than 16% of the falls resulted in fractures. Perhaps this large percentage is due to the large proportion of women in the study group (more than 80%). Moreover, it cannot be excluded that not all falls, especially those which are not accompanied by a fracture, were recorded.

Malnutrition is a common problem in the older population. It causes deterioration of functioning, increased bone and muscle loss, and increased risk of falling.¹⁶ In our study, a general relationship between nutritional status and fall or fracture incidence has been observed. The role of the greater accumulation of fat in reducing the risk of fractures (particularly femoral neck fractures) is explained by 3 mechanisms: greater support of the bone, the shock-absorbing function of the soft tissues during the fall, and an increased ability to produce endogenous estrogen.³⁴ The elderly population is not recommended to lower their BMI below 25 kg/m² (the upper limit of the normal range according to the World Health Organization), not only because of the lower risk of some fractures but also because of the increased survival of people who are within overweight BMI range (25–30 kg/m²).³⁵

The accumulation of physical and mental deficits that occur among older people may reduce the ability to perform daily routine activities and increase the likelihood of a fall. According to Chu et al.,³⁶ fallers experience a greater decrease in the score for basic activities of daily living and complex activities of daily living. In a Finnish cohort study with an 8-year follow-up, fractures associated with falls were found to be an independent factor associated with functional decline in the elderly.³⁷ An inverse relationship has also been observed: functional deficits, as an independent factor, increase the risk of falls and fractures.³⁸ Also, in the present study, we observed a number of associations between physical functioning (ADL, IADL, TUG) and a history of falling and fractures.

Both restricted mobility and a history of falling (and to a greater extent, a history of fall and fracture) lead to functional decline and fewer social contacts that provide the so called positive support.⁷ This may affect a further deepening of functional deficits but also lead to depression or deepen its symptoms. Chu et al.³⁶ suggested that low activities of daily living and depression are 2 significant risk factors of first and recurrent falls. Some studies showed that mental dysfunction, such as depression or cognitive impairment, may double the risk of falling.³⁹ In our study, however, older people with a history of falling had no worse cognitive performance or symptoms of depression than those without such history.

Several limitations of the present study should be acknowledged. Usually, subjects with relatively good physical and cognitive functional status are able to participate in such studies, and especially to undergo functional tests. In the present study, only about 40% of all nursing home residents were able to participate. The frequency of falls is usually prone to underreporting, and it cannot be excluded that this was also the case in the present survey. Finally, the study focused on the association between RTIs and fall incidence, but other infections (e.g., of the urinary tract) may also contribute to this relationship.

We conclude that the risk of falling and fracture in nursing home residents is associated with the occurrence of RTIs. A low WHR is a risk factor for falls with fractures. Older subjects who experienced a fall with a fracture are characterized by a worse functional status. Preventing infections may probably reduce the number of falls and fractures in older residents of the nursing homes.

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Infekcje dróg oddechowych a występowanie upadków u pensjonariuszy domów opieki

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SŁOWA KLUCZOWE

infekcje, sprawność funkcjonalna, starzenie się, upadki, złamanie

STRESZCZENIE

WPROWADZENIE Upadki to złożone zdarzenia spowodowane przez wspólnie występujące wewnętrzne zaburzenia i niepełnosprawności ze współistniejącymi czynnikami środowiskowymi lub bez nich.

CELE Celem badania była ocena związku pomiędzy zakażeniami dróg oddechowych (*respiratory tract infections* – RTI) oraz występowaniem upadków, a także zależności między upadkami a stanem funkcjonalnym wśród pensjonariuszy domów opieki.

PACJENCI I METODY Badaniem objęto 255 pensjonariuszy trzech domów opieki w wieku ≥ 65 lat. Upadki i RTI rejestrowano przez 1 rok, po którym u każdego badanego wykonano całościową ocenę geriatryczną.

WYNIKI U 104 badanych miał miejsce upadek, przy czym u 17 z nich doszło również do złamania. Wśród badanych, u których wystąpiło złamanie stosunek talii do bioder (*waist-to-hip ratio* – WHR) był mniejszy w porównaniu z pensjonariuszami, u których nie doszło do złamania. Osoby ze złamaniem w wywiadzie charakteryzowały się istotnie gorszym stanem czynnościowym w zakresie zarówno podstawowych jak i złożonych czynności dnia codziennego. U pensjonariuszy domów opieki z upadkiem w wywiadzie zano- towano więcej infekcji niż u tych, u których upadek nie wystąpił (odpowiednio: $1,53 \pm 1,31$ i $1,03 \pm 1,17$; $p < 0,001$). Podobnie, badani ze złamaniem w wywiadzie przebyli większą liczbę infekcji w porównaniu z pensjonariuszami bez złamania (odpowiednio: $1,82 \pm 1,07$ i $1,19 \pm 1,26$; $p = 0,012$). Po uwzględnieniu innych zmiennych w wieloczynnikowym modelu, RTI pozostały niezależnym predyktorem występowania upadków i złamań.

WNIOSKI Ryzyko upadku i złamania u pensjonariuszy domów opieki jest związane z występowaniem RTI. Mała wartość WHR stanowi czynnik ryzyka upadków ze złamaniem. Starsi pensjonariusze ze złamaniem w wywiadzie charakteryzują się gorszą sprawnością funkcjonalną. Zapobieganie infekcjom może zmniejszyć liczbę upadków i złamań wśród starszych pensjonariuszy domów opieki.

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